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**ON THE OCCURRENCE OF URANIUM, SILVER, IRON, ETC., IN THE
TERTIARY FORMATION OF COLORADO TERRITORY.**

BY E. L. BERTHOUD.

November 24th, 1874, I was called upon to measure and examine a coal mine called the Lyden Coal Mine, six miles north of Golden, Colorado Territory. The measurement and the examination were required to ascertain precisely what the explorations to that date had done towards striking and opening up one of the largest beds of tertiary coal that lie in the upturned stratification of the Northern Colorado Coal Field, which the exhaustive examinations and reports of Professors Hayden, Lesquereux, Cope, Gardner, and Mauris on the coal fields of the eastern slope of the Rocky Mountains have so largely elucidated; but where close proximity to the cretaceous, and the "*delusion*" of a local inversion, have given some cause for doubts on the part of eminent geologists as to the real position of the beds. But conceiving that this point is now settled, it appears that the "*raison d'être*" of the dispute lies in offending cretaceous mollusca, that in Wyoming are found regularly above beds of lignite coal, whose position is inferentially identified with that of other formations lying above them that are confessedly acknowledged to be tertiary; until the general "*homologies*" or succession of beds in Wyoming Territory are more definitely settled, and compared rigorously with our Colorado lignite deposits of like age, we must admit them by force of evidence as cretaceous.

But in the Colorado coal formation east of the mountains the cretaceous fossils we find at the base of the Rocky Mountains are invariably west of the outcrop of coal, and in the descending series; thus we are compelled to believe that this is no longer a question for argument, and we shall speak of this coal field as, without doubt, a tertiary deposit. The Lyden coal mine of Jefferson Co., Colorado Terr., lies in Section Twenty-eight (28), Township 2 S., Range 70 west, C. T., about $1\frac{1}{2}$ miles east of the metamorphic and eruptive rocks of the five ranges of the Rocky Mountains. The trend of the outcrop of cretaceous and tertiary strata that here are locally known as "*Hogbacks*" is N. 17° to N. 19° west, which is also that of the coal beds intercalated in the tertiary shales, clays, and sandstones. The coal and its accompanying walls are

nearly vertical, but they occasionally dip 5° , 7° , 8° to the west, causing a local inversion.

The Lyden coal mine lies in an oblong ridge, isolated mostly in a small basin of erosion one mile north of Ralston Creek.

The ridge, with its weather-worn castellated summit, is 700 or 800 feet wide, and nearly one-half mile long; a parallel outcrop of cretaceous sandstone, dipping east about 30° , and succeeded by a ridge of red sandstone, is found one mile west of the coal outcrop. In order then to reach the coal bed in the cheapest and most expeditious manner, a drift was started from the west slope, and, cutting at right angles to the stratification, reached a distance eastwards of 310 feet horizontal, and over 200 feet below the top edge of the sandstone outcrop. At about 270 feet from the entrance of the drift a small vein of coal was pierced through, about 15", then two more larger beds, making altogether about five feet of good coal in three beds. Penetrating east some ten feet beyond the last coal bed, the miners were astonished to find, in place of the ten to twelve feet coal bed, the object of their search, an exceedingly hard black vein of mineral matter, containing geodes of brilliant quartz crystals, and small veins of pyrites, the honeycombed mineral full of a green ochrey powder, with veins of chalcedony, and small orange-colored crystals and concretions.

Upon further examination I found that this mineral vein, resembling a very dark hard iron ore, had apparently been thrust up from below as a "dike," that it had taken the place of and destroyed the coal bed that it had apparently obliterated; that the country rock, a soft sandstone with clay shale or fine clay, was disrupted, fragmentary, and in irregular order, the intruded "dike" having the appearance of being the produce, or at least at one time subjected to heat; yet the adjacent rock is but little if any changed, and in the vein we find everywhere in small particles unconsumed coal, but more particularly in the honeycombed portions of the mineral.

Altogether, from the peculiar appearance of the intruded "dike," and its violent intercalation in the recent tertiary strata, we find a complete substitution of the coal took place in this part of the coal outcrop, for by digging upwards good coal is found above the "dike," for another drift has been extended nearly 200 feet or more in a northerly direction on the workable coal bed. But in this drift, after entering on the coal bed from the south end

of the "Hogback," in over 60 feet distance the "dike?" or bed of metamorphic iron ore, etc., was reached, cutting off the coal completely. Upon following upwards the face of the intruded bed of ore, the "big coal bed" was again reached in fifteen feet vertical elevation. The mine was worked for a long distance northwards, until a sudden flow of choke-damp killed all the miners, when the last named drift was abandoned, and the new drift driven crosswise to locate and open up the workable coal bed.

Having selected different varieties of the ore that the intruded "dike" contains, and having them analyzed, I find that the intruded "dike" carries from 2 to $\frac{2}{10}$ per cent. of uranium, and 8 oz. bullion; that iron is present in a large proportion, but no zinc or manganese. The coal is of the same general quality as the Murphy, Coal Creek, and Golden coal. It is metamorphosed lignite, and contains 47 to 51 per cent. carbon, $13\frac{1}{2}$ to $19\frac{1}{2}$ per cent. of water, $4\frac{1}{2}$ to 5 per cent. ash, 35 to $32\frac{1}{2}$ per cent. volatile matter. The fossil vegetation of the shale and coal bed sandstones contain fossil leaves of cinnamomum platanus, pharagmites, magnolia platanus, and juglens, etc. etc. One and one-half miles southwest of this mine, and in the cretaceous outcrop one-half mile west of Murphy's mine, we find the summit of the Hogback formed by a "dike" of erupted basalt or dolerite whose course is nearly on the meridian.

Notes on Mr. Berthoud's Paper.—Dr. GEORGE A. KÖNIG remarked that the facts detailed in the above paper are of great interest, but the Academy cannot endorse the author's views upon the origin of this mineral deposit. There was a time when anything unusual in the earth's architecture was attributed to the mischievous agents of the great fiery abyss.

But chemical investigation has proved that all the fissure veins, as well as stratified ore beds, are the result of a long process of reduction, crystallization, and deposition of mineral substance from aqueous solution.

While in many cases the satisfactory explanation of disturbances in stratified rocks and especially mineral veins and coal beds is very difficult with our present knowledge, nay impossible, yet in this instance, there is no difficulty, nor even anything strange.

The ore deposit is perfectly conformable with the strike and dip of the coal bed ; mining operations have developed the presence of coal above the ore, and, no doubt, would reveal it below the level of the drift, if a shaft were sunk to the requisite depth. The presence of geodes of fine quartz crystals and chalcedony, as also the presence of pyrite, excludes all idea of igneous origin (*à priori*), and makes the ore deposit analogous to the filling of fissure veins by the process of infiltration. The infiltration may have been *synchronic* with the deposition of the organic matter forming the coal bed, as undoubtedly the masses of iron carbonate and iron oxides in the coal beds of many localities were; or it may have taken place by replacement at a later period. To decide about these two ways, it would be necessary to examine the deposit more closely than has apparently been done. But either of them is consistent with the chemico-geological theories now held by geologists.

PHILADELPHIA, August 14th, 1875.

Mr. GABB remarked that while the observation given in Mr. Berthoud's paper was interesting, the writer's deduction was evidently at fault. From the description of the facts as given, it seemed to be a case of replacement by segregation, similar to that which occurs in the manganese mine of "Red Rock" in the bay of San Francisco, where beds of metamorphosed cretaceous shale are pseudomorphed by segregated masses of black oxide of manganese; in many parts the original bedding of the siliceous rock being retained, but the material consisting of nearly pure metallic oxide.